IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors:	Jaime Poris		
Assignee:	Nanometrics Incorporated		
Title:	Method of Measuring Dishing		
Serial No.:	09/578,798	Filing Date:	May 23, 2000
Examiner:	William C. Choi	Group Art Unit:	2873
Docket No.:	NAN040 US	Confirmation No:	5190

COMMISSIONER FOR PATENTS
Washington, D. C. 20231

DECLARATION PURSUANT TO 37 C.F.R. §1.131

Dear Sir:

This Declaration is offered to prove conception and reduction to practice of Claim 1 in the above-referenced application (the "Application") prior to April 4, 2000, the effective priority date of U.S. Patent No. 6,340,602 B1 to Johnson et al.

I, Jaime Poris, the sole inventor in the present patent application, declare as follows:

1. That sometime prior to April 4, 2000, while employed by the Assignee, Nanometrics Incorporated ("Nanometrics"), I conceived of a method of measuring the dishing of a first feature surrounded by a second feature, by generating calibration data, measuring the height variation of the first feature, and correlating the height variation with the calibration data to determine the amount of dishing, as recited in Claims 1, 2, 3, 4, and 10 of the Application. The conception of the invention is substantiated by the enclosed exhibit as follows.

2. Exhibit A is a copy of an internal Nanometrics' invention disclosure entitled "A Procedure to Measure Dishing of Opaque Features Caused by a Polishing Process" prepared by myself in the United States prior to April 4, 2000. The invention disclosure was submitted to the patent attorney prior to April 4, 2000, to assist him in preparing the Application. Dates and portions (including pages 2 of 5 and 3 of 5) of the invention

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disclosure that are immaterial to the conception of the invention recited in Claims 1, 2, 3, 4, and 10 have been deleted.

3. As can be seen in Exhibit A, page 4 of 5, the proposed procedure described in the invention disclosure included "generat[ing] a set of calibration curves," "measure[ing] the height variations of a copper surface", and "the amount of dishing can be calculated for that specific region of the wafer when compared to the calibration curves". Similarly, on page 5 of 5, the disclosure includes a proposed Claim 1, which recites "measure[ing] the shape of a chosen opaque feature" and "the correlation of this shape with the amount of dishing observed at this opaque feature by comparison to generated calibration curves." Thus, the relevant portions of the invention disclosure in Exhibit A contain all the elements of Claim 1. In addition, all the elements of Claims 2, 3, 4, and 10 may be found on page 5 of 5 in the proposed claims. For example, Claim 2 may be found in proposed Claim 1, Claim 3 may be found in proposed Claims 2 and 4, Claim 4 may be found in proposed Claim 3, and Claim 10 may be found in proposed Claims 5 and 6.

4. Accordingly, Exhibit A shows that the subject matter of Claims 1, 2, 3, 4, and 10 of the Application was conceived prior to April 4, 2000.

I assert that all statements made herein on my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Respectfully Submitted,

Jaime Poris

Dated: 10/14/02

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DECLARATION BY APPLICANT'S ATTORNEY
PURSUANT TO 37 C.F.R. §1.131

Dear Sir:

Michael J. Halbert declares as follows:

1. I am currently a partner in the firm Silicon Valley Patent Group LLP, 2350 Mission College Boulevard, Santa Clara, California.

2. I was an associate at the firm Skjerven Morrill MacPherson LLP, 25 Metro Drive, San Jose, California (referred to herein as "Skjerven"), and was responsible for preparing the above-referenced application (the "Application"). The Application was prepared for Nanometrics Incorporated (referred to herein as "Nanometrics"), and was assigned attorney docket number "M-8555" by Skjerven.

3. Attached hereto as Exhibit A is a copy of an internal Nanometrics' invention disclosure entitled "A Procedure to Measure Dishing of Opaque Features Caused by a Polishing Process" prepared by Jaime Poris, dated prior to April 4, 2000, and used by me in preparing the Application. The invention disclosure of Exhibit A is covered by Claims 1, 2, 3, 4, and 10 of the Application. Dates and portions (including pages 2 of 5 and 3 of 5) of the invention disclosure that are immaterial to the conception of the invention recited in Claims 1,

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2, 3, 4, and 10 have been deleted. The invention disclosure was received by Skjerven prior to April 4, 2000.

4. Prior to April 4, 2000, Skjerven opened a file for the Application. The opening of the file is evidenced by a letter, a copy of which is in the Application's file. This work is also reflected in my daily time log, a copy of which is attached as Exhibit B. The date of the daily time log has been deleted.

5. Beginning on April 4, 2000, and continuing until April 25, 2000, I was engaged in the preparation of an initial draft of the Application. This work is reflected in my daily time logs for April 4, 2000, April 8, 2000, April 15, 2000, April 16, 2000, and April 24, 2000, copies of which are attached as Exhibits C, D, E, F, and G, respectively.

6. On April 25, 2000, I finalized an initial draft and mailed that draft to Nanometrics for Mr. Poris' review. On April 26, 2000, I emailed a soft copy of the draft to Mr. Poris. The transmittal of the draft Application is evidenced by a letter, a copy of which is in the Application's file. This work is reflected in my daily time logs for April 25, 2000 and April 26, 2000, copies of which are attached as Exhibits G and H, respectively.

7. It is my understand that, during the time period from Mr. Poris' receipt of the initial draft until about May 13, 2000, Mr. Poris was engaged in reviewing the initial draft of the Application.

8. On May 13, 200, and May 15, 2000, I reviewed the comments provided by Mr. Poris and had a telephone conversation with Mr. Poris to discuss his comments. I also revised the Application in response to Mr. Poris's comments. On May 15, 2000, I transmitted a second draft of the Application to Mr. Poris. This work is reflected in my daily time logs for May 13, 2000 and May 15, 2000, a copy of which is attached as Exhibit I.

9. It is my understand that, during the time period from Mr. Poris' receipt of the second draft until about May 19, 2000, Mr. Poris was engaged in reviewing the second draft of the Application.

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10. On May 19, 2000, I reviewed comments that were provided to my by Mr. Poris and I revised the Application accordingly. This work is reflected in my daily time log for May 19, 2000, a copy of which is attached as Exhibit J.

11. On May 22, 2000, I finalized the Application. It is my understanding that Mr. Poris approved the Application and executed the inventor's declaration on May 22, 2000. The Application was filed the next day, i.e., May 23, 2000, as evidenced by the filing date of the Application. This work is reflected in my daily time logs for May 22, 2000 and May 23, 2000, a copy of which is attached as Exhibit K.

I assert that all statements made herein on my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Dated: 10-16-02

Respectfully submitted,

Michael J. Halbert
Attorney for Applicants
Reg. No. 40,633

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Jaime Poris

A PROCEDURE TO MEASURE DISHING OF OPAQUE FEATURES CAUSED BY A POLISHING PROCESS

EXHIBIT A

The proposed procedure is to relate the radius of curvature within the metal feature to the amount of dishing. If this can be done, the dielectric regions need not be measured. To generate a set of calibration curves, a properly chosen number of experiments should be run on a common set of samples with a fixed set of CMP parameters. The analysis of these experiments along with an independent measurement of the amount of dishing (using a calibrated atomic force microscope (AFM) for example) should result in a quantitative relationship between metal line width, metal density, average radius of curvature and dishing. The experiments should be repeated at other values of important CMP parameters to determine if the relationship between dishing and average radius of curvature is modified by the CMP processing parameters. After generating an adequate set of calibration curves, measurements can then be made at a multitude of specific areas on a wafer to quantify dishing by comparing the results to the set of calibration curves.

There are a number of methods that could be used to measure the height variations of a copper surface. One such method uses a differential interferometer. A beam of radiation is divided into two beams with orthogonal directions of polarization. After striking the surface, the two beams are recombined and the intensity of the beam is measured. Any variations in vertical displacement between the two spots results in a phase shift which causes a change in the intensity. The local change in slope or height can be measured as the two small, adjacent spots traverse a metal feature. The shape of the copper surface can be determined from a multitude of measurements. The radius of curvature (or a more complex mathematical entity) can then be calculated from the shape of the surface and the amount of dishing can be calculated for that specific region of the wafer when compared to the calibration curves.

Another method uses a laser displacement sensor. A small spot laser is focused onto the copper surface. The position of the reflected beam is then measured. This is repeated as the beam is scanned across the metal feature. The positional data can be converted to an average radius of curvature and the amount of dishing can be calculated for that specific region of the wafer.

The proposed procedure is to relate the radius of curvature within the metal feature to the amount of dishing. If this can be done, the dielectric regions need not be measured. To generate a set of calibration curves, a properly chosen number of experiments should be run on a common set of samples with a fixed set of CMP parameters. The analysis of these experiments along with an independent measurement of the amount of dishing (using a calibrated atomic force microscope (AFM) for example) should result in a quantitative relationship between metal line width, metal density, average radius of curvature and dishing. The experiments should be repeated at other values of important CMP parameters to determine if the relationship between dishing and average radius of curvature is modified by the CMP processing parameters. After generating an adequate set of calibration curves, measurements can then be made at a multitude of specific areas on a wafer to quantify dishing by comparing the results to the set of calibration curves.

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Another method uses a laser displacement sensor. A small spot laser is focused onto the copper surface. The position of the reflected beam is then measured. This is repeated as the beam is scanned across the metal feature. The positional data can be converted to an average radius of curvature and the amount of dishing can be calculated for that specific region of the wafer.

CLAIMS

1. A procedure to measure the shape of a chosen opaque feature on the surface of a flat substrate composed of more than one material after a polishing process and the correlation of this shape with the amount of dishing observed at this opaque feature by comparison to generated calibration curves.

2. The procedure in claim 1 used to measure the shape of a metal feature on the surface of a flat substrate composed of metal and dielectric materials.

3. The procedure in claim 2 with the metal feature being predominantly composed of copper, aluminum or tungsten.

4. The procedure in claim 2 with the material surrounding the metal feature being composed of a dielectric material.

5. The procedure in claim 1 utilizing a differential interferometer to measure the shape of the opaque feature.

6. The procedure in claim 1 utilizing a laser displacement sensor to measure the shape of the opaque feature.

CLAIMS

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2. The procedure in claim 1 used to measure the shape of a metal feature on the surface of a flat substrate composed of metal and dielectric materials.

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4. The procedure in claim 2 with the material surrounding the metal feature being composed of a dielectric material.

5. The procedure in claim 1 utilizing a differential interferometer to measure the shape of the opaque feature.

6. The procedure in claim 1 utilizing a laser displacement sensor to measure the shape of the opaque feature.